A MODIFICATION OF HEDIN'S HEMATOKRIT.

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I DO not know that there is any necessity to apologize for bringing up this matter when the direct references to it in the English medical literature accessible to me are contained in Von Jaksch's *Clinical Diagnosis*,[2] and the *New York Medical Journal*, February 3, 1894, p. 151. The latter reference gives an abstract of the contents of a paper by Dr. Judson Daland, read before the New York Academy of Medicine on January 16, 1894, to which I refer those interested for nearly all the practical information extant upon the subject. Dr. Daland, with Dr. Carl Sadler, of Prague, has for some time been collecting data relating to the instrument, in the ultimate usefulness of which he expresses an abiding faith on what appeals to me as a most rational basis.

My own irregular mode of life, almost devoid of free moral agency, from the very nature of my position, has prevented me up to the present time from adding any connected observations to those cited. I can only state that I have found the estimates of

[1] Read before the San Francisco Bacteriological Society August 1, 1894.

[2] Charles Griffen & Co., London, 1893, p. 25.

the numbers of the corpuscles by percentage-volumes, as given by Dr. Daland, correct within the limits assigned by him in the comparative estimations that I have made, using the Zeiss-Thoma hemocytometer; but these have been few in number, and not in all cases above reproach as to the exactness of their technical performance.

I hope to be able to make a number of observations upon the members of the crew of the U. S. Coast-Defense vessel *Monterey*, and upon opportunity to extend them so as to include pathologic blood-states; but this is a matter of conditional promise, and, like *obiter dicta*, of little binding force and effect.

On February 15, 1894, I devised a modification of Hedin's instrument, substituting rubber blocks for the springs used to hold the tubes in place and to prevent leakage; it is shown in Fig. 1, in place upon a small electric motor hereinafter to be described.

It was with this now discarded design that nearly all of my observations have been made. I think it satisfactory as an hematokrit of the kind promulgated by its originator; and I believe that the further modification that I have introduced, of measuring the heights of the columns of corpuscles by direct reading with low powers (× 200 or less) of the microscope from the limb graduated for recording the lateral motion of the mechanical stage, instead of the set graduations upon the tubes containing the diluted blood, is really an improvement worthy of the name. The method of taking the reading is shown in Fig. 2, the microscope resting

FIG. 1.

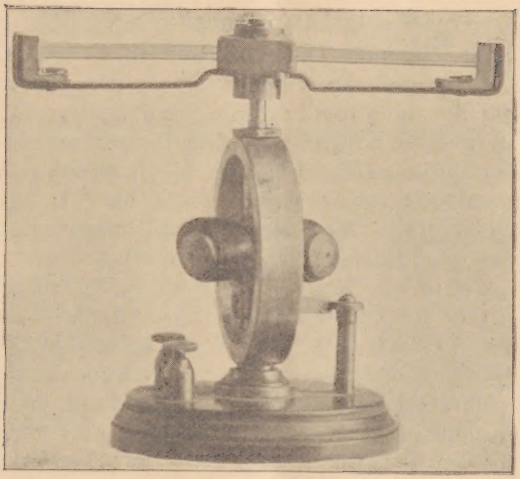
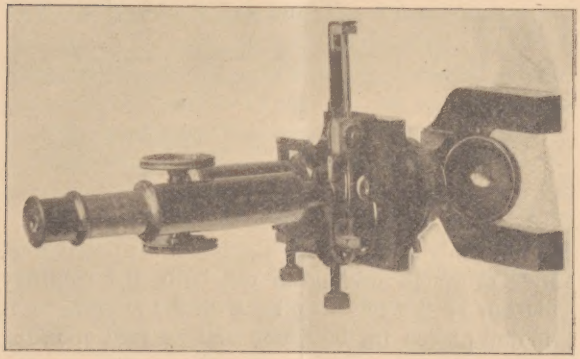


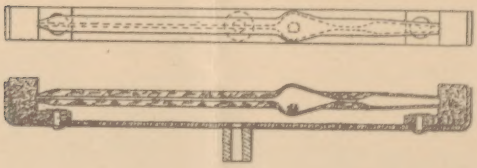
FIG. 2.



on a support upon the edges of its stage and of its foot, to prevent bevelling of the tops of the columns of the corpuscles, which occurs in other positions, from gravitation. Of course, some forms of microscopic stands will not lie in this position, but very little ingenuity would obviate this difficulty.

Within the past week, considering the sources of error introduced and the trouble involved in the process of transferring the diluted blood from the capillary tube, for measuring and mixing, to the tubes of the hematokrit, I have designed a frame capable of receiving and holding during rotation the tube for measuring and mixing itself. This is shown *in situ* in Fig. 3, which is a reduced working drawing, complete even to the conventional hatchings for the representation of composition, of rubber, and of glass. For this refinement I am indebted to a messmate, Passed Assistant Engineer G. S. Willits, U. S. Navy, who has made both the frame and this drawing of it.

FIG. 3.



With this arrangement the blood is diluted, and, after thorough mixing in the bulb, the capillary portion of the tube is filled with the mixture to its tip and placed in the frame and secured upon the

motor, or upon the train of gearing for rotating. The result of effective rotation will be that all of the fluid above the center of form of the tube (its tip being considered as the lower end) will run into the bulb and that part of the tube above it, while the longest possible column of blood (for a given length of tube) of constant length and of absolutely exact dilution will be separated into its particulate and fluid components.

Then, either the graduations on the tube, or the microscope and its mechanical stage (and I prefer the latter as more nearly conforming to the best scientific methods of measuring with great accuracy), may be used to get the percentage-volume. The capillary tube that I employ is that furnished with the Zeiss-Thoma apparatus for counting the colorless blood-cells. There is no reason why the finer tube supplied for counting the red blood-cells should not be used instead. I employ the first named because it is more easily cleaned.

I am sorry that my experience does not enable me to speak definitely about the best diluent to be used. Separation is certainly easy with solution of potassium bichromate (2.5 per cent. strength, recommended by Daland[1] as the best of nineteen fluids tried); but I have found a liberation of gas—presumably oxygen—to be associated with the use of this, and it has proved troublesome by disturbing the layer of the colorless corpuscles. I have seen large bubbles rise and carry a line of red cells high into the supernatant liquid when the tube was under microscopic observation as depicted in Fig. 2.

[1] Loc cit.

By most fixing-solutions, such as Hayem's, separation is made impossible.

Coagulation vitiates the results in all cases in which it occurs, by entanglement of the cells in the meshes of the fibrin and by the bulk of the fibrin itself. It would be a great aid if it could be prevented by some vaporous agent, which would obviate the necessity of diluting the blood.

It would be a great mistake to imagine that, using blood thus diluted, the layer of colorless blood-corpuscles will obtrude itself upon the notice of even a reasonably careful observer. It is not, at least in normal blood, nearly so wide as a church door; and it is best described as a cream-colored or buff-colored tip upon the comparatively long column of red blood-corpuscles. Daland[1] indicates briefly this indefiniteness. I have found Müller's fluid, deeply tinged with methyl-violet, to aid somewhat in differentiating the layer of colorless corpuscles. It has the disadvantage of coloring the blood-plaques, which would, in that event, vitiate the result in proportion to their number. Daland says that this occurs in the absence of stains, or rather he notes a case in which the blood-plaques proved a source of annoyance.

Obviously, therefore, this instrument cannot replace the hemocytometer, which, with all its faults, will remain a claimant for interested favors, if not of affection, at our hands. But it may save time, and the great nervous strain inseparable from counting the squares, by indicating those cases that un-

[1] Loc cit., and American Journal of the Medical Sciences, vol. cvii, p. 511.

equivocally demand its assistance. Personally, I have never found any employment so irksome as the accurate use of this excellent instrument of precision; hence I am willing, at the risk of imputation of laziness to myself, to allow electricity to remove this irksomeness, if it can be done (as I think it can be) in a perfectly trustworthy manner.

I hope sincerely that some of the gentlemen of the Bacteriological Society of San Francisco, or others of the medical profession to whom this product of enforced idleness may come, will find the subject of sufficient interest to enlist their aid in determining the limitations and the usefulness of the principle embodied in the instrument described. My own *clientèle* is limited perforce to men so carefully selected that dyscrasiæ, such as leukocythemia, should not, and as a matter of fact do not, often occur; so that the best results I could secure under exceptionally favorable conditions would deal only with states of comparative health, and these seem to be of the least importance of all the data necessary for the present status of the hematokrit, and its early establishment as a factor for constant use in diagnosis.

A word regarding the motor shown in Fig. 1, which is one-half size; it is, I believe, the invention of a New York dentist, and its resemblance to the gyroscope is apparent, the limbs of the moving part of that toy being the magnets, and the spindle upon which they revolve the shaft of this machine. The analogue of the frame of the toy is here the armature, composed of "soft" iron, and the presence of the current in it adds to the

efficiency of the motor very decidedly, but in a manner not easily explicable, so electricians inform me. It will run at a speed of from 1200 to 2000 revolutions per minute in circuit with an ordinary incandescent lamp; and four Daniell or bichromate cells, or any good cautery battery, will drive it well with a fair load. I have used it for two years for centrifugal separation in urinalysis and for the little use I have made of Charcot's and Luys' *miroir rotatif*. It may be obtained from Frank Wilks, Scott's Wharf, Newport, Rhode Island, to whom I am indebted for much valuable information, and whose thoroughness as a designer and as an accomplished artisan it affords me much pleasure to acknowledge.

U. S. Coast-Defence Vessel "Monterey,"
Navy Yard, Mare Island, Cal.